



First record of genus *Imparfinis* from a northeastern coastal Brazilian river basin: *I. borodini* Mees & Cala, 1989 in Rio de Contas, Bahia

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Abstract: *Imparfinis borodini* Mees & Cala, 1989 is recorded in low population abundance in the upper Paraná, Tocantins and São Francisco river drainages according to the scientific literature and available collection data, but it has not been previously recorded from a coastal Brazilian river. Herein, the geographic range of this species is extended to the Rio de Contas basin in northeastern Brazil. This represents the first record in a coastal system. Additionally, *I. borodini* was captured in the middle Rio São Francisco at Barreiras. Both new records are the first from Bahia state, Northeastern Brazil.

Key words: Atlantic Forest; Caatinga; Heptapteridae; Northeastern Brazil; Rio São Francisco; taxonomy

The catfish family Heptapteridae includes peculiar forms, with troglomorphic species such as *Rhamdiopsis krugi* Haseman, 1911, from Chapada Diamantina, Bahia state (Bockmann and Castro 2010), and miniature species, which besides small size (less than 20 mm in standard length), show reduction on laterosensory canals, bones and number of rays, as exemplified by *Horiomyzon retropinnatus* D.J. Stewart, 1986 from the upper Amazon (Weitzman and Vari 1988). Members of Heptapteridae are arranged in 24 genera that include 208 valid species (Eschmeyer and Fong 2015). The group is one of the most representative members of the order Siluriformes in small water bodies in South America.

Although the family is recognized as monophyletic (Bockmann and Guazelli 2003), it lacks external morphological attributes that allow easy recognition, being

instead identified by a group of general anatomical features present in other Neotropical families (Lundberg and McDade 1986; Lundberg et al. 1991; Bockmann 1998). In spite of the unquestionable family monophyly, the taxonomic status of some genera remains less precise and such situation includes *Imparfinis* Eigenmann & Norris, 1910, as stated by Ortega-Lara et al. (2011). On the other hand, the *Nemuroglanis* subclade is a well-corroborated group within heptapterids (Ferraris 1988; Bockmann 1994), recognized on the basis of 16 synapomorphies, mostly associated with the Weberian complex and fin supports. This clade comprises *Acentronichthys* Eigenmann & Eigenmann 1889, *Cetopsorhamdia* Eigenmann & Fisher 1916, *Chasmocranus* Eigenmann 1912, *Heptapterus* Bleeker 1858, *Horiomyzon* Stewart 1986, *Imparfinis* Eigenmann & Norris 1900, *Mastiglanis* Bockmann 1994, *Nannoglanis* Boulenger 1847, *Nemuroglanis* Eigenmann & Eigenmann 1889, *Pariolius* Cope 1872, *Phenacorhamdia* Dahl 1961, *Rhamdioglanis* Ihering 1907, *Rhamdiopsis* Haseman 1911, and *Taunayia* Miranda-Ribeiro 1918 (Lundberg and McDade 1986; Bockmann and Ferraris 2005). *Phreatobius* Goeldi 1905, stated as a member of heptapterid clade *Nemuroglanis* by the above mentioned authors, was recently recognized as a separate clade recognized within the superfamily Pimelodoidea. In spite of its highly distinct morphology, such features do not provide strong evidence for family-level placement (Sullivan et al. 2013).

The genus *Imparfinis* is a poorly diagnosed genus, with generic recognition based on an array of osteological features, as presented in Bockmann (1998) and also the presence of a dark band along lateral line. Additional

external features for generic recognition include branchiostegal rays 6–8, usually 7; branched rays on pectoral fin 7–10, usually 8 or 9; anal fin bearing 11–14 rays, usually 12–13 rays; caudal fin with 7 branched rays in upper lobe and 8 in lower lobe (Bockmann 1998). The presence of conspicuous bars on flanks is observed in some *Imparfinis* species, including *I. borodini* Mees & Cala, 1989. Although the number of bars varies between the species, such a feature deserves further investigation for generic assignment, since it is also observed in *Chasmocranus* species.

The genus includes 19 species (Eschmeyer and Fricke 2015), and is one of the most broadly distributed within the family Heptapteridae, from streams in Costa Rica to the Paraná and Uruguay river basins in Argentina, and to both sides of the Andean cordillera (Ortega-Lara et al., 2011). The easternmost record is that of *I. borodini*, for the São Francisco River basin.

Imparfinis borodini was described in 1989 from Franca, Rio Grande basin, upper Paraná system, São Paulo, on the basis of a single specimen (AMNH 8639). The name *I. borodini* was proposed in face of a homonymy case, in substitution of *I. longicauda* Borodin (1927), preoccupied by its senior homonym *I. longicauda* Boulenger (1887), that was described from the Rio Bobonaza basin, upper Rio Pastaza drainage, Ecuador (Mees and Cala 1989: 387).

The species is characterized by the elongate, slender body, ending in a very long falcate caudal fin obliquely asymmetric; long adipose fin; and 4 to 5 transverse bars on flanks (Borodin 1927). This species have fins devoid of spines, with 7 to 8 branched rays on pectoral and anal fins, 6 branched rays on upper caudal lobe and 7 on lower; eyes in dorsal position; low body depth (10–12% in standard length [SL]); and presence of a dark stripe along the lateral line (LMSS, pers. obs.).

Currently, *I. borodini* is recorded for upper Tocantins, upper Paraná and São Francisco river drainages. A single record is given to the upper Tocantins at Serra da Mesa River dam in Goiás state (Miranda and Mazzoni 2003). In the upper Paraná drainage, this species is widely distributed, with records for the Brazilian states of Goiás (Pavanelli et al. 2007), São Paulo (Rondineli and Braga 2010; Oyakawa and Menezes 2011), Paraná (Galves et al. 2007; Cunico et al. 2009), and Mato Grosso (collection data). According to the literature, the species occurs in low population abundance, and is found in third and fourth order streams (e.g., Pinto 2009; Takahashi 2010). For the Rio São Francisco basin the species was recorded in Minas Gerais state, at its upper and middle stretches, and also in the Distrito Federal (Species Link; Figures 1 and 2). Otherwise, no literature records indicate its occurrence for the

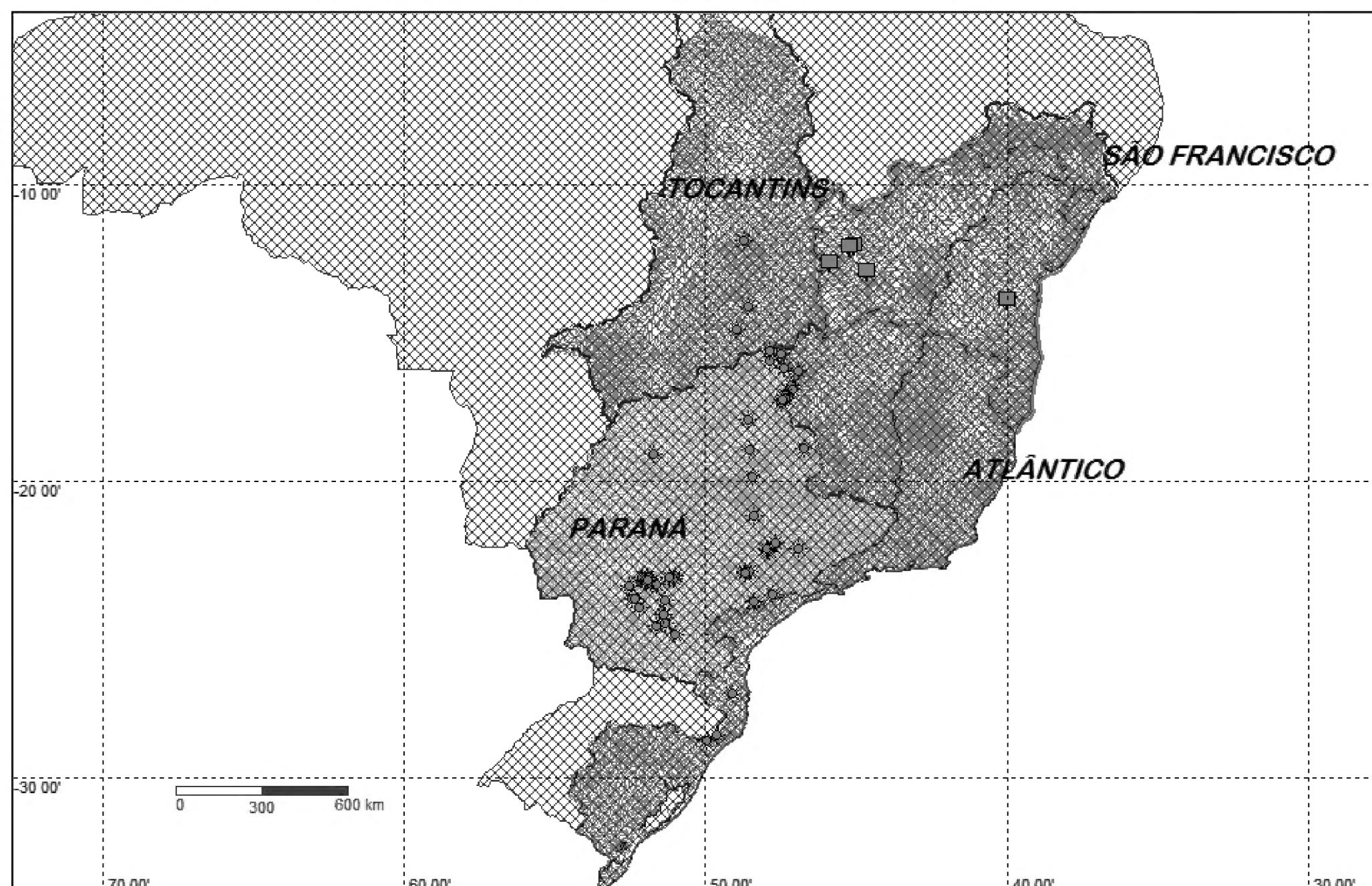


Figure 1. Records of *Imparfinis borodini* (red dots) in Brazil. Additional records in Bahia are indicated by green rectangles. See Figure 2 for additional information on Bahia records. The major Brazilian river basins are indicated by green and dark blue and are the Paraná, Tocantins and São Francisco basins, respectively. The coastal Atlantic drainage is indicated by light blue. Bahia State is outlined in yellow.

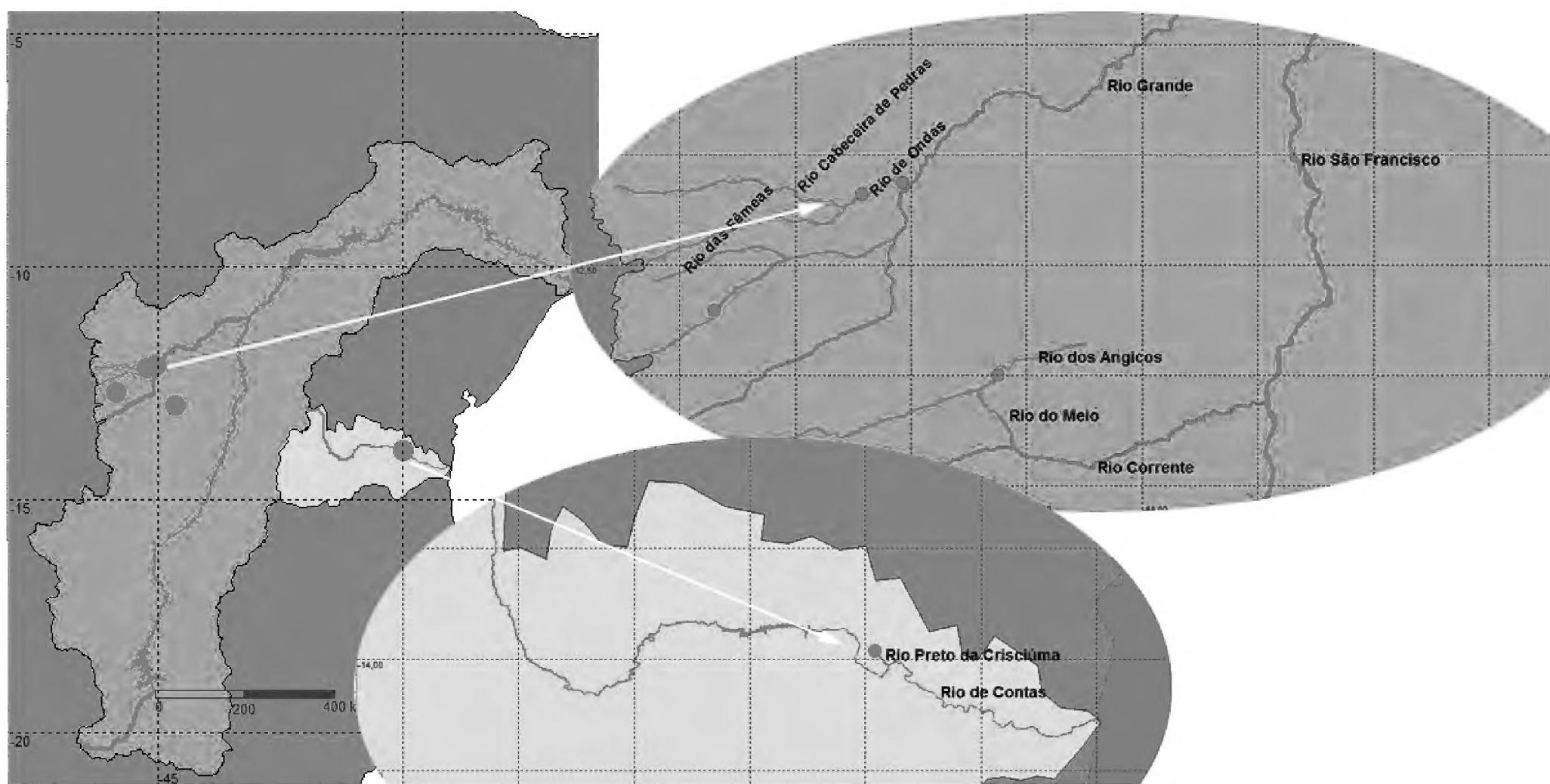


Figure 2. Records of *Imparfinis borodini* in Bahia State, Brazil. The basins of the Rio São Francisco and Rio de Contas are green and light pink, respectively.

sub-middle and lower stretches of the Rio São Francisco in Bahia state.

Recent samplings in the Rio de Contas basin revealed the presence of *Imparfinis borodini*, representing the first record of the species from this drainage (Figures 2 and 3). The Northeastern Mata Atlantica freshwater ecoregion, as stated by Abell et al. (2008), includes all coastal river basins between the Rio Itabapoana (Rio de Janeiro and Espírito Santo states) in the south and Rio Sergipe (Sergipe state) in the north. The whole area is delimited on the west by the Rio São Francisco watershed along the Espinhaço mountain range. The record of *I. borodini* in the Rio de Contas basin constitutes the

first occurrence of the genus in the Northeastern Mata Atlantica freshwater ecoregion (Figure 2; ecoregion 328 of Abell et al. 2008).

The Rio de Contas basin, situated in central-south Bahia and the largest basin completely within in the state, occupies about 10.2% of the state's territory. Near its headwaters, in Jequié municipality, the Rio de Contas is dammed for energy production by the Barragem de Pedra, which is controlled by the Companhia Hidro Elétrica do São Francisco. Downstream from that barrier the main tributaries of Rio de Contas are Rio Jequiezinho and the Rio Preto do Craciúma. The Rio Preto do Craciúma a left margin tributary in the middle

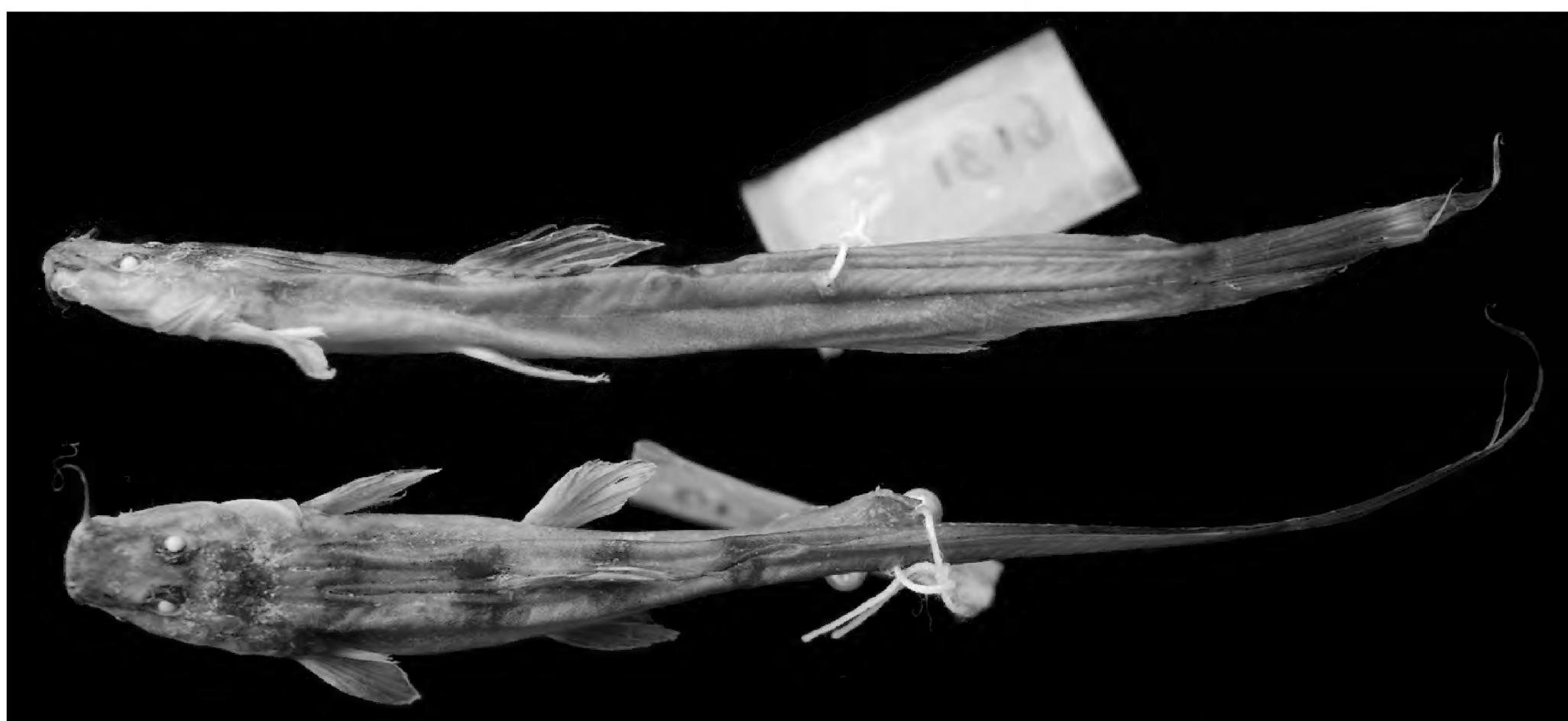


Figure 3. *Imparfinis borodini*, MBML 30327, 68.9 mm SL, Rio Preto do Craciúma, Rio de Contas basin, Jitaúna, Bahia, Brazil. Lateral and dorsal views.

stretch of the Rio de Contas, in the municipality of Jitaúna, drain a transition zone between the Caatinga and Atlantic Forest biomes. It is situated between Jequié and Jitaúna municipalities and was the object of research on fish communities (e.g., Barreto and Xavier 2003; Xavier 2003; Oliveira 2012; Souza 2015).

One specimen of *Imparfinis borodini* was captured in the Rio Preto do Críciúma (Figure 4). The stretch of the Rio Preto do Críciúma where *Imparfinis borodini* was found is shallow (ca. 20 cm to 1 m deep), with rapids over rocks, sand and silt, and pools about 2.5 m deep and 13 m wide. Waters are clear, warm (21–31°C) and oxygenated (7.8 mg/l). Water current between pools and rapids were 0.36–0.55 m/s (Barreto and Xavier 2003). Marginal vegetation consists in grass, and remnants of riparian forest. Along the Rio Preto do Críciúma granite blocks were quarried at the end of the 20th century. Nowadays, the edges of the river are occupied by familiar agriculture, mainly horticulture.



Figure 4. Collecting locality of *Imparfinis borodini* at Rio Preto da Críciúma, downstream of the Rio de Pedras dam, Rio de Contas basin, in Jitaúna near border with Jequié, Bahia, Brazil.

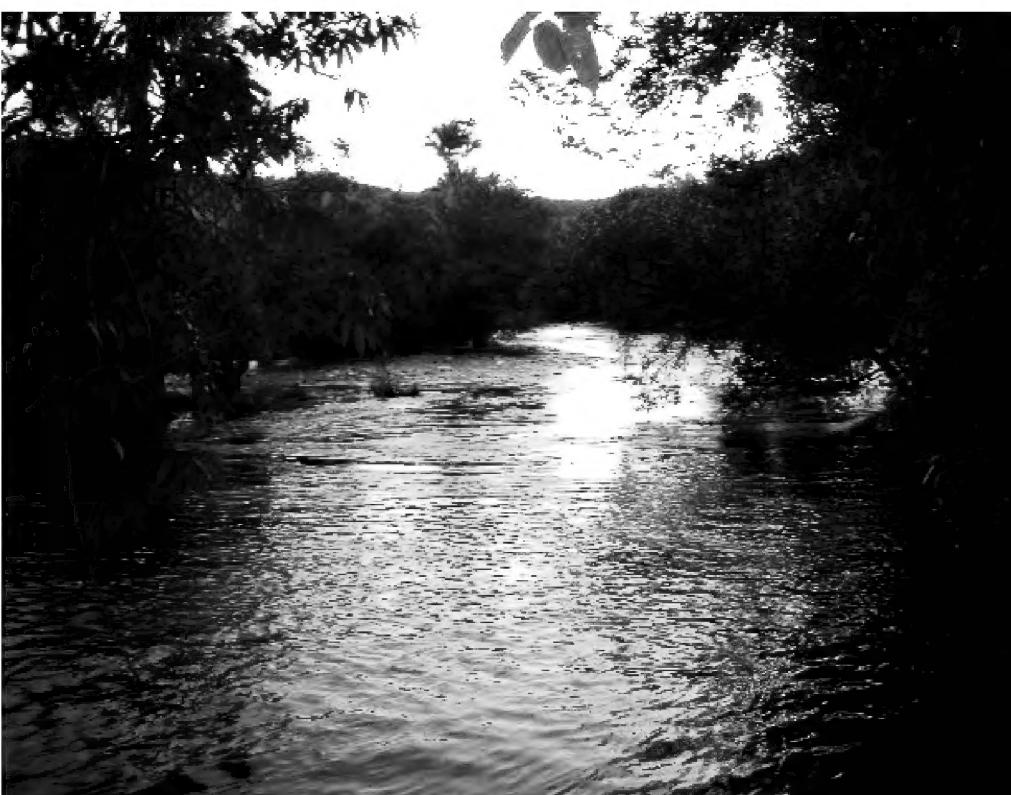


Figure 5. Collecting localities of *Imparfinis borodini* along the Rio de Ondas, Barreiras, Bahia, Brazil.

The other specimens of *I. borodini* were captured in two stretches of the Rio de Ondas (Figure 5), a tributary of the Rio Grande, which is itself a tributary of the middle portion of the São Francisco River. The sampled stretch (ca. 1.2 m deep) was relatively fast running and clear and predominantly rocky with sand and pebbles. The remaining marginal vegetation with shrubs and trees of Buriti (*Mauritia flexuosa*). Various anthropic disturbances are found along the river, including water extraction for irrigation and supplying the cities of Barreiras and Luís Eduardo Magalhães, and for recreation (Moraes 2003). *Imparfinis borodini* was found associated with vegetation debris, near the riverbank in a flooded stretch with a sequence of cascades (ca. 40–60 cm high).

This species was recorded in syntopy with *Astyanax* sp., *Hypostomus* sp., *Pareiorhaphis* sp., *Parotocinclus jimi* Garavello 1977, and *Geophagus* sp. in the rio Preto do Críciúma, and with *Astyanax fasciatus* (Cuvier 1819), *Bryconops* aff. *affinis*, *Cichlasoma sanctifrangiscence* Kullander 1983, *Myleus micans* (Lütken 1875), and *Serrapinnus heterodon* (Eigenmann 1915) in the Rio de Ondas. Some of these species have a preference for well-oxygenated waters in rapids.

Imparfinis borodini was defined as of Least Concern, and not threatened with extinction in the national Brazilian Red List (Brazil, Ministério do Meio Ambiente 2014). Particularly, the conservation status of *I. borodini* is uncertain in the state of Bahia, based on the limited knowledge of its geographic distribution. The species is so far known from two areas, a tributary of the Rio de Contas, subject to permanent anthropic perturbation, and a tributary of the Rio São Francisco, also with a series of anthropic alterations. However, given the absence of studies on population biology and geographical range of the species, we are unable to assess the effect of these putative threats on the conservation of *I. borodini* and on the maintenance of its populations within the



state of Bahia. Thus, *I. borodini* would be classified as data deficient (DD), albeit not assessed using the International Union for Conservation of Nature (IUCN) categories and criteria. Additional collecting efforts should be conducted in that region in order to better understand biological aspects and distribution of the species.

The species was not included among the freshwater fish species of Bahia, during the meetings for evaluation of endangered fauna of the state (Jucá Chagas et al. 2015).

A recent study of the species distributions of the Northeastern Mata Atlantica ecoregion and the fish fauna shared with adjacent ecoregions by Camelier and Zanata (2014), listed 28 species shared between Northeastern Mata Atlantica and the São Francisco ecoregion (without considering species that are widely distributed and taxonomically problematic species, such as *Characidium* spp., *Hypostomus* spp., *Trichomycterus* spp.). The discovery of new occurrences, such as those of *I. borodini*, and the lack of knowledge of the distributions of species within taxonomically difficult groups of the above genera attests for the incomplete taxonomic knowledge of the fish diversity of the ecoregion. Taxonomic revision of these problematic species groups and samplings efforts are encouraged to better understand the composition and distribution of species throughout Northeastern Mata Atlantica river systems.

Regarding the species shared between the Northeastern Mata Atlantica and the São Francisco ecoregions, most of these occur in rivers, such as the Rio Itapicuru and the Rio Paraguaçu, in the northern portion of the Northeastern Mata Atlantica. Camelier and Zanata (2014) recorded three of those species in the Rio São Francisco basin and a group of rivers of the Northeastern Mata Atlantica ecoregion that includes Rio de Contas, named Central-South group (*Cichlasoma sanctifranciscense*, *Pamphorichthys hollandi* (Henn 1916), and *Phenacogaster franciscoensis* Eigenmann 1911). *Imparfinis borodini* represents the fourth species shared by the Rio de Contas and São Francisco basins. According to Camelier and Zanata 2014, the southernmost limit of distribution of these shared species is the Rio de Contas. South of the Rio de Contas, the taxonomic affinity and the presence of shared species between the eastern Brazilian basins and the Rio São Francisco basin clearly decreases.

Geomorphological evidence indicates an ancient drainage connection among eastern basins and the Rio São Francisco basin. Cenozoic captures of tributaries of the ancient São Francisco drainage are evidenced by the large number of wind gaps, which are valleys where water once flowed (Saadi 1998). Dry former watercourses bordering the Espinhaço mountain range,

are testimonies of old connections between the São Francisco and coastal basins (King 1956).

The Espinhaço mountain chain represents the most extensive and continuous elevation within Brazilian territory (Almeida-Abreu and Renger 2002). It was formed during the Mesoproterozoic Era as a product of cover sequence over the adjacent stable eastern São Francisco craton, partially reworked by the Brasiliano Araçuaí Fold Belt (Almeida-Abreu 1995; Almeida et al. 2000). During the Mesozoic and Cenozoic eras erosive events, denudation cycles, and blocks tilting occurred. During this time, a connection may have occurred between the Rio de Contas and São Francisco basins that would explain the shared fish fauna. However, such stream captures are not yet fully comprehended. Further investigation into past river connections and their timing are needed for a better understanding of faunal connections.

Ribeiro (2006) applied the term “Pattern C” to distributions that reflect the most recent exchanges between the upland crystalline shield rivers and the adjacent coastal drainages, recognized on the basis of shared species, and, in some cases, of hybrid zones. According to Camelier and Zanata (2014) six species are currently known to occur only in the Rio São Francisco basin and basins of the north portion of Northeastern Mata Atlantica: *Hypessobrycon micropterus* (Eigenmann 1915), *Lepidocharax burnsi* Ferreira, Menezes & Quagio-Grassiotto 2011, *Oligosarcus argenteus* Günther 1864, *Prochilodus costatus* Valenciennes 1850, *Steindachnerina elegans* (Steindachner 1875), and *Phenacogaster franciscoensis*. These species appear to exemplify “Pattern C” as defined by Ribeiro (2006). Most of these species have a somewhat broad distribution, occurring also in some of the coastal drainages north to the Rio São Francisco, and also in the Rio Paraná basin. In turn, the authors also state that only *Acetrorhynchus lacustris* (Lütken 1875), *Cetopsorhamdia iheringi* Schubart & Gomes 1959, *Hemigrammus marginatus* Ellis 1911, *Hypessobrycon bifasciatus* Ellis 1911, *Piabina argentea* Reinhardt 1867, *Prochilodus vimboides* Kner 1859, *Serrapinnus heterodon* (Eigenmann 1915), *S. piaba* (Lütken 1875), and *Trachelyopterus striatulus* (Steindachner 1877) are shared between the drainages of the Northeastern Mata Atlantica ecoregion and the Rio Paraná basin (LMSS and AMZ, pers. obs.). On the other hand, *Imparfinis borodini* is shared between both São Francisco (ecoregion 327), Northeastern Mata Atlantica (ecoregion 328), Upper Paraná (344 ecoregion) and Tocantins-Araguaia (ecoregion 324) freshwater ecoregions (numbers in parentheses *sensu* Abell et al. 2008).

Biogeographical explanations aside, the *I. borodini* population in the Rio de Contas is known only by a single specimen that was found by us. It is interesting to note that Borodin (1927) stated in the original description of

the species that the adipose fin does not reach the caudal fin and this condition can be verified in his illustration (Figure 3 of Borodin, 1927) and in the photograph of the holotype (AMNH 8639; available at ACSI 2015). The rio de Contas specimen has the adipose fin almost connected to the caudal fin. Further investigations regarding the population of *I. borodini* in Rio de Contas are desirable, once additional specimens are found.

Comparative material examined. Brazil: Bahia. Jitaúna: MBML 10327, 1 (68.9 mm SL), Rio Preto do Criciúma, downstream from Barragem das Pedras dam, near border with Jequié, Rio de Contas basin, $13^{\circ}57'55.9''$ S, $039^{\circ}057'26.8''$ W, 267 above sea level (a.s.l.), M. Anjos and L.A.S. Santos, 12 January 2015.

Barreiras: MBML 10729, 12 (61.6–102.2 mm SL), lower stretch of Rio de Ondas, upstream of Barreiras, Rio Grande sub-basin, Rio São Francisco basin, $12^{\circ}07'47''$ S, $045^{\circ}02'06''$ W, M.C. Moreira and E.R.R.S. Castro. UFBA 6162, 1 (98.3 mm SL), Rio de Ondas on its confluence with Rio das Pedras, Rio Grande sub-basin, Rio São Francisco basin, 677 a.s.l., $12^{\circ}14'21''$ S, $045^{\circ}17'07''$ W. R. Burger and J. A. Reis, 12 February 2009.

Additional material in Species Link. Brazil: Bahia. São Desidério: UNT 09543, 2, Rio dos Angicos, Rio Corrente sub-basin, São Francisco basin, $12^{\circ}42'25''$ S, $045^{\circ}50'44''$ W, A. Akama and A.B. Soares, 25 October 2008.

Roda Velha: UNT 10048, 1, Rio Roda Velha, in Roda Velha de Baixo village, Rio Grande sub-basin, São Francisco basin, $11^{\circ}59'00''$ S, $048^{\circ}39'34''$ W, A.B. Soares, E.F. Oliveira and V.C.O. Marto, 11 October 2010.

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